PARASITIC COPEPODA FROM MARINE COASTAL FISHES IN THE KAIKOURA-BANKS PENINSULA REGION, SOUTH ISLAND, NEW ZEALAND. WITH A KEY FOR THEIR IDENTIFICATION

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ABSTRACT

An introductory account of parasitic Copepoda in New Zealand waters is given, together with suggestions for collecting, examining, preserving and disposal of specimens. A key is presented for identifying all known forms from the fishes which are known to occur in the Kaikoura-Banks Peninsula region. Nine species/subspecies (+ 2 spp.indet.) have been taken from elasmobranch fishes, 13 (+ 7 spp.indet.) from teleost fishes in the region; a further 6 from elasmobranchs and 27 (+ 1 indet.) from teleosts are known in New Zealand waters but so far not taken from these hosts in the region. A host-parasite list is given of known records from the region.

KEYWORDS: New Zealand, marine, fish, parasitic Copepoda, keys.

INTRODUCTION

Fishes represent a very significant proportion of the macrofauna of the coastal waters from Kaikoura to Banks Peninsula, and as such are commonly studied by staff and students from the Department of Zoology, University of Canterbury. Even a cursory examination of most specimens will reveal the presence of sometimes numerous parasites clinging to the outer surface or, more frequently, to the linings of the several cavities exposed to the outside sea water. The mouth and gill chambers are

particularly liable to contain numbers of large or small, but generally macroscopic, animals attached to these surfaces. Many are readily identified as segmented, articulated, chitinised animals and are clearly Arthropoda. Inspection of their appendages leaves no doubt that they are, further, Crustacea.

Two major groups of crustaceans are known to parasitise fishes. One of these is the Isopoda: either large (several cm long) wood-louse-like animals, attached to the outer surface or buried to a greater or lesser extent in the flesh - these are the 'fish-lice' which can inflict considerable damage to the host; or small (few mm long) swollen-bodied forms in the mouth/gill cavities or on the outer surface - these are the *praniza* larvae of Gnathiidae, whose adults are free-living. The taxonomy of the isopods is to be found in Hurley (1961).

Most crustacean parasites of marine fishes belong to the Copepoda, though some are so modified as to be barely recognisable even as crustaceans. While a number of parasitic copepods have been described from New Zealand, undoubtedly there are more species (many probably new) awaiting discovery from searched and unsearched hosts. Even those recorded are mostly poorly known especially in regard to the two sexes, to their biology, life history, and prevalence and intensity of infestation. Most publications, even beyond New Zealand, are in the necessarily first stage of taxonomy and morphological description. By contrast, very little is known of the biology of any parasitic copepod.

No key to their identification in this country is available and the present paper attempts to remedy this deficiency. Given the abundance of host fishes, and their frequent examination in laboratories, it is desirable to provide some basic information necessary to study the parasitic copepods. There is no doubt that, if an animal can be named, more interest is shown in it, especially since information about it or closely related forms is often available in the world literature. Interest in this fascinating group of extraordinary parasites is burgeoning, and it is desirable to build up a solid collection of data and of specimens. Both the Isopoda and the Copepoda are known elsewhere to be serious parasites of economic importance in fisheries.

MORPHOLOGY AND BIOLOGY

Copepods are not only the most abundant but are also the most varied of the Crustacea which parasitise fishes. Their morphology ranges from clearly recognisable, well-segmented, leg-bearing forms related to free-living Copepoda (e.g. Bomolochidae, fig.32; Ergasilidae, fig.58) to extremely modified, often bizarre shapeless bodies bearing little resemblance to Copepoda or even to other Arthropoda (e.g. Sphyriidae, fig.54; Pennellidae, fig.59). These latter forms retain few of the normal copepod appendages, and even those may be found only with a high-power microscope; their true relationships can be deduced from phylogenetic considerations and from studies on their life history (see Kabata, 1979, 1981b).

In size they range from a few mm in length for adult females to ca 150 mm (*Sphyrion*). Some of the miniature males - themselves 'parasitic' on their females - are only a few hundred µm long (fig.63).

They are found freely moving on the body surface (Caligidae, which are even able to leave the host and swim to infect another individual), or attached to the surface, to the inside of the mouth and respiratory cavities or to gill filaments (many families), inside nasal sinuses, lateral-line canals, or even deeply embedded in the flesh (Philichthyidae). Apart from this last family, they show adaptations to their parasitic mode of life in the form of their attachment organs: very mobile forms (Caligidae) have enlarged hook-like second antennae; in others it is the second maxillae which become enlarged to claw-like structures (Lernanthropidae, and many other families), or wrap round the gill filaments to which they merely adhere (Naobranchiidae, fig.60), or even fuse at their tips to form a 'bulla' with an adhesive disc (Lernaeopodidae, figs 28, 29, 47).

All have mandibulate mouth-parts which rasp or tear away at host tissue. Some, especially gill parasites, are found engorged with blood; others appear to feed more extensively on tissues and body fluids of the host, inflicting considerable damage.

LIFE HISTORIES

Mature females - the stage most commonly collected - produce a continuous stream of large numbers of eggs, a phenomenon common to many parasites whose life history involves great hazards to survival. The eggs continue their development in masses forming compact *egg sacs* (fig.41), or in long slender *egg strings* (figs 48-50) which may trail behind the body often exceeding the body length. In the strings, eggs may be *multiseriate* (several eggs per cross section, figs 41, 47) or *uniseriate* (in a single row, figs 45, 49, 50). These features are characteristic and are useful in taxonomy.

From the egg there emerges a free-swimming *nauplius* larva which moults to give as many as 5 stages; the last stage is followed by *copepodid* larvae (up to 4 stages) in which more segments and appendages become developed; attachment to the definitive host follows and the now *chalimus* larvae (also up to 4 stages) begin metamorphosis into the adult form. (In the Pennellidae, the chalimus, having settled on one host, moults and becomes free-living again, finally settling on its definitive host; the first host may be the same species as the final one or it may even be an invertebrate.) It is in the planktonic nauplius and copepodid stages that great losses must occur; but it is also there that the morphology is revealed to place these animals unequivocally within the Copepoda, despite the bewildering appearance of some adults.

Males may be collected along with the females, but their form and occurrence vary considerably within the group. Males of many families in New Zealand resemble the corresponding females but may be smaller, and their abdomen and appendages are morphologically distinct. At the other extreme, males may be miniature 'dwarf' individuals, often attached to the female cephalothorax or abdomen (Chondracanthidae; Lernaeopodidae, fig.28); or freely associated with the female in her 'cyst' (Philichthyidae). They may be transient and not persist after fertilising the female (Lernaeopodidae, Sphyriidae), while in a few cases (Pennellidae, some Ergasilidae) fertilisation occurs in the pre-settlement stage, so that the male is not found on the parasitised host.

Many males are unknown or unidentified as to the species of female with which they are associated; in New Zealand very few examples of pre-adult stages are known (see, e.g. Hewitt, 1964a), and even the mature males are not known for a number of species. Immature females which have settled on the host but have not yet developed adult characteristics may resemble adult males; this stage is, however, short-lived and is not often found.

As might be expected in a group with very ancient origins (recognisable parasitic copepods have been found in the lower Cretaceous, 100 Ma b.p.), there is much variation in life histories; a great number are unknown or incompletely worked out.

An excellent review of the situation and problems of interpretation is to be found in Kabata (1981b).

EXAMINATION OF HOSTS; PRESERVATION AND STUDY OF PARASITIC COPEPODS & DISPOSAL OF SPECIMENS.

Host fishes should be examined as soon as possible after being caught, otherwise external mobile forms (Caligidae) may be lost. More firmly attached forms may be sought at leisure and may also be found in preserved host material. They should be looked for especially on the respiratory surfaces of the mouth, gills and gill cavities, in the spiracles, nasal cavities, lateral-line canals, and cloaca. Most can be removed undamaged by gentle use of fine forceps, but the firmly attached and partly embedded forms (Pennellidae, Philichthyidae, Sphyriidae) must be dissected out from host tissues; care should be taken to ensure that hooks and embedded holdfasts are removed intact and that the ultimate, often ramifying, branches are not cut off. (The holdfast of *Trifur lotellae* (fig.59) may even penetrate bony structures of the mouth.) When in doubt, prefer to dissect out a piece of host tissue with the parasite attached.

Fixation is best made with formalin (7% in sea water, or 10% neutral (buffered)), and the parasites stored in 70% alcohol (+ a few drops of glycerol as insurance against drying out).

Collecting data should include not only the host name, locality, date, and collector's name, but also the site or organ from which the parasite was taken. It is of the utmost importance to ensure that the host is correctly identified - as will be seen from records in the Key, many copepods are recorded from a single host species; this is not to be taken as indicating absolute host-specificity and great care must be exercised in recording collections for it is on such data that future records will be based. Incorrect labelling in this regard will inevitably lead to incorrect host-parasite associations in the literature. These are extremely difficult to eradicate and will lead to endless, fruitless, searching and to misconceptions about relationships. If the host name is uncertain or unknown, this fact should be stated on the data label.

Most parasitic copepods can be examined, for identification, in the unmounted state, though some may need partial dissection and at least temporary slide-mounting to resolve features of the appendages. Temporary mounts may be made in sea water or, better, lactic acid; a Berlese-type mountant is also excellent for dissecting in and for long-term slide-mounts - it softens brittle specimens and is water-soluble; its chief disadvantage is that it requires that the cover slip be ringed with a varnish to prevent shrinkage of the mountant. Phase contrast microscopy is advantageous for small or thin specimens or parts, and may be used with wet or with permanently mounted material; its use avoids the necessity of staining. If staining is desired, Carbol Fuchsin or Chlorazol Black E may be used, but care should be taken not to overstain, especially in the latter. Whole mounts in Canada Balsam may be satisfactorily made from very flat specimens, e.g. Caligidae, Cecropidae.

Dwarf, attached ('parasitic') males are best left *in situ;* if they become dislodged they should be preserved along with their associated female specimen in the same tube or in an inner small vial.

Many hosts have no parasitic copepods recorded from them yet, but they should nevertheless be thoroughly examined for them. The parasites included in this paper are those which have either been taken in the Kaikoura-Banks Peninsula region, or been reported elsewhere in New Zealand from hosts which are themselves known to occur in the region. With regard to the latter category, it might be expected *a priori* that further collecting will reveal the presence of the parasites in the region; but there remains to be considered the possible occurrence of localised populations of hosts and/or parasites - some parasites reported in North Island fishes may not occur in the same host species from South Island waters. Indeed, the reverse is apparently true in the case of *Polyprion oxygeneios* which has been found to harbour a copepod of the family *Eudactylinidae* at Kaikoura (Pilgrim, unpubl.), whereas this parasite has not been taken in extensive searching in northern waters (Hewitt, pers. comm.).

Collecting of the parasites in the region is unquestionably very incomplete and many hosts remain to be examined; even those listed are most probably not exhaustively searched yet, and information on *site* of occurrence of the parasites is needed. Some copepods show variability according to the organ/site at which they attach to the host: the form and branching of the holdfast of *Trifur lotellae* appears to reflect some response according to the host tissue invaded, while the general body form of, e.g. *Hatschekia* spp., seems to vary under perhaps similar influences.

Much can be done to add to the body of information by the steady accumulation of data. (It is a little disconcerting to find reports on New Zealand parasitic Copepoda appearing in Russian and Polish literature, as has happened in the past several years). Specimens should not be discarded so long as they are in at least reasonable condition and are combined with the relevant collecting data. They should be deposited in a collection where adequate curation and accessibility may be expected: University Zoology Departments, Museums (especially National Museum which has a responsibility for the N.Z. Arthropod Collection), or Fisheries Research Division (M.A.F., Wellington). A lot more extensive and intensive collecting is called for before a significant 'Check-list' of the parasitic copepods of the region can be produced.

CONSTRUCTION AND USE OF THE KEY

No attempt has been made to design a completely 'natural' key, reflecting phylogeny. The classification follows that of Kabata (1979) with regard to the allocation of genera into families; this differs from some previous accounts (e.g. Wilson, 1932; Yamaguti, 1963) but is based on a series of convincing morphological grounds. The key is also broadly dependent on Kabata (1979), but draws on various taxonomic papers for more restricted groups. Some of the detail is specifically applicable to New Zealand forms, and characters have been chosen as far as possible to enable indentification without dissection (which often entails destruction of the specimen).

In many cases where males and females are not dissimilar (e.g. Caligidae, Cecropidae), both sexes will key out satisfactorily. At the other extreme (e.g. Chondracanthidae, Lernaeopodidae, Philichthyidae, Sphyriidae) the males are either minute, grossly dissimilar, often attached (sometimes temporarily) to the female, or are unknown in this country; the key will thus be relevant to females only, but attached males may be identified 'by association'.

The family summaries are 'thumb-nail sketches' compiled with particular reference to known New Zealand species - they should be read in conjunction with characters given in the keys. These 'diagnoses' may need to be relaxed when other members are discovered.

After each identity, the *known New Zealand* hosts are listed; where records include published or unpublished material from Kaikoura-Banks Peninsula an asterisk * is added. Square brackets denote a reference or source of figures, descriptions, etc., of the parasite.

It is not the function of this paper to provide a complete synonymy of any of the hosts or parasites. Most of the names are as given in Francis (1979), or Roberts & van Berkel (1982), or Ayling & Cox (1982) (fishes), and in Hewitt & Hine (1972) (fishes and parasites), or in the respective more recent publications. In a few cases the names in Hewitt & Hine have been updated to conform with later publications, but no opinion is offered as to the validity of such synonymies.

In accordance with the concept that *it is paramount to identify the host*, couplet 1 of the key unashamedly, if somewhat unscientifically, separates the parasites according to the type of fish host. Only Eudactylinidae & Lernaeopodidae are so far recorded from both elasmobranchs and teleosts in the region - they will therefore appear in the key in two places. (Specimens from an unknown host can of course be run through both parts of couplet 1).

The information recorded is that known to the writer as at March, 1985.

KEY TO ADULT COPEPODA PARASITIC ON MARINE FISHES OF THE KAIKOURA-BANKS PENINSULA COAST

1	Occurring on elasmobranch fishes		2
1a	Occurring on teleost fishes		p25
2	Body dorso-ventrally flattened (fig. 2,3, 6-13)	PANDARIDAE	p 22
2a	Body not dorso-ventrally flattened (fig. 1, 28,29)		3
3	Second maxillae enlarged into arm-like structures fused at the tips into a 'bulla' (fig. 28,29) ..... (part - also occur on teleosts) males small and attached to females	LERNAEOPODIDAE	p 21
3a	Second maxillae free, not fused at tips; bulla absent		4
4	Body very elongate and slender, length at least 10x width; dorsal shield with articulated posterior stylets (fig. 62)	KROYERIIDAE	p 21
4a	Body more compact, length less than 5x width		5

5	Four pairs of biramous, non-foliaceous legs ..... (part - also occur on teleosts)	EUDACTYLINIDAE	p 20
5a	Three pairs of foliaceous legs, dovering ventero-lateral parts of posterior trunk (fig. 1)	DICHELESTHIIDAE	p 20

FAMILY: DICHELESTHIIDAE

Stout-bodied; second antennae greatly enlarged; body with pairs of expanded foliaceous processes; egg strings long, trailing, uniseriate. Males resembling females. One species in New Zealand, found on many parts of the body, often deeply embedded. *Anthosoma crassum* (fig.1); on *Carcharodon carcharias*, Galeorhinus australis, Isurus oxyrinchus*, Lamna nasus**. [Hewitt, 1968c]

FAMILY: EUDACTYLINIDAE

Body rather cylindrical, with well-defined terga; second antennae uncinate; 4 pairs of biramous legs; egg strings very long, trailing, uniseriate. Males resembling females. [Hewitt, 1969c]

Key to New Zealand species:

1	First antenna bent between second and third segments (fig. 16); maxilliped chelate in female (fig. 20), subchelate in male (fig. 21) ..... [unrecorded specimens from *Squalus acanthias**]	*Eudactylina* sp.	
1a	First antenna straight; maxilliped subchelate in both sexes	*Nemesis* spp.	2
2	With egg strings	females	3
2a	Without egg strings	males (and immature females)	5
3	Four free trunk segments approximately equal in width, without lateral projections (fig. 22, 23)	*Nemesis lamna* s.l.	4
3a	Fourth free trunk segment much narrower than segments 1-3, which are broader than long (fig. 24) ..... on *Alopias vulpinus*.	*Nemesis robusta*	

4 Free trunk segments separated by deep sinuses, giving each segment a convex lateral margin (fig. 23) ..... *Nemesis lamna lamna* on *Carcharodon carcharias*, Isurus oxyrinchus*.*

4a Free trunk segments separated by shallow indentations, each segment having almost straight margins (fig.22) .... *Nemesis lamna vermi* on *Cetorhinus maximus*.*

5 With 4 abdominal segments (fig. 25) ..... *Nemesis robusta*

5a With 3 abdominal segments (fig. 26, 27) 6

6 First 3 free trunk segments broader than long (fig. 26), with convex margins .. *Nemesis lamna lamna*

6a All four free trunk segments approximately equal in width, almost rectangular, some with almost straight margins (fig. 27) ..... *Nemesis lamna vermi*

FAMILY: KROYERIIDAE

A very small family (fewer than 20 spp.); female elongated with 3 well-defined leg-bearing segments behind the cephalothorax, followed by a long genital complex, and a small abdomen; second antenna chelate; male similar but smaller. [see Kabata, 1979, for a general account] (fig. 62).

One species in New Zealand, on gills of *Galeorhinus australis** ..... *Kroyeria* (*?lineata*)

FAMILY: LERNAEOPODIDAE

Body of female of various forms, but never flattened: second maxillae modified and united into a 'bulla' of two arm-like structures fused at their tips where hooks serve to anchor the copepod to the host (fig. 28,29); trunk enlarged into a genital sac without appendages; egg sacs often longer than rest of the body, multiseriate.

Males, minute (fig. 28), attached to (often immature) females, dying after fertilisation. Occur on variety of sites on body surface, and especially on gills, of Elasmobranchs and Teleosts (both marine and freshwater).

Key to New Zealand species (females only) occurring on Elasmobranchs:

1 Cephalothorax well-sclerotised, less than half length of trunk (fig. 28) ..... *Lernaeopoda galei*
on *Galeorhinus australis*, Mustelus lenticulatus*, Squalus acanthias** [Thomson, 1890]

1a Cephalothorax poorly sclerotised, about 2/3 as long as trunk (fig. 29) ..... *Charopinus parkeri*
on *Raja nasuta*, Squalus acanthias**
[Thomson, 1890; Kabata, 1964]

FAMILY: PANDARIDAE

Dorso-ventrally flattened; cephalothorax with well-defined, roughly semicircular shield; trunk with conspicuous dorsal or dorso-lateral plates; adhesive pads often present on ventral surface; egg strings long, trailing, uniseriate.

Males (where known) resembling females, but plates reduced in number and size. Most species (all known New Zealand species) occur on Elasmobranchs, usually on outer surface, fins, skin.

Key to New Zealand species:

1 With egg strings ..... adult females 2

1a Without egg strings ..... males and immature females 10

2 Third free trunk segment with well-sclerotised 'elytra'-like dorso-lateral plates covering ca half of next segment (genital complex, fig. 3) ..... *Echthrogaleus coleoptratus*
on *Lamna nasus*, Prionace glauca**
[Hewitt, 1967; Kabata, 1979, regards *E. braccatus* as a synonym]

2a Third free trunk segment without such 'elytra'-like plates 3

3 Rami of legs 1-4 with 2 segments each; all with long plumose setae (fig. 4) ..... *Demoleus latus*
on *Squalus acanthias* [Hewitt, 1967]

3a Rami of legs 1-4 with different numbers of segments; some without plumose setae, but with spines (fig. 5) 4

4 Rami of at least some legs with plumose setae 5

4a Rami of all legs without plumose setae, but with spines 7

5 Legs 1-3 with rami 2-segmented, leg 4 with rami 1-segmented; abdomen 1-segmented; genital complex without posterior lobes (fig. 6) ..... *Nesippus orientalis*
on *Mustelus lenticulatus*, Notorynchus cepedianus, Raja nasuta**. [Note: *Nesippus borealis* may key out here but is known in New Zealand from a single ♂ taken from *Isurus oxyrinchus*, see Hewitt, 1967; Kabata, 1979 tentatively includes *borealis* under the genus *Nogagus*]

5a Leg 1 with rami 2-segmented, legs 2-3 with rami 3-segmented, leg 4 with rami 1-segmented; abdomen 2-segmented; genital complex with 2 posterior lobes (fig. 7) ..... *Dinemoura* spp. 6

6 Third free trunk segment with posteriorly-directed U-shaped lobes (fig. 2) ..... *Dinemoura producta*
on *Carcharodon carcharias*, Cetorhinus maximus* [Hewitt, 1967]

6a Third free trunk segment with posteriorly-directed lobes, each with a pronounced lateral expansion (fig. 7) ..... *Dinemoura latifolia*
on *Carcharodon carcharias, Galeorhinus australis, Isurus oxyrinchus* [Hewitt, 1967]

7 Second free trunk segment with plates equal to, or shorter than, those of first free segment (fig. 8) 8

7a Second free trunk segment with plates longer than those of first free segment which considerably overlap those of the second (fig. 9) ..... *Phyllothyreus cornutus*
on *Isurus oxyrinchus* [Hewitt, 1967]

8 Genital complex roughly rectangular, obscuring abdomen in dorsal view (fig. 8); legs 1-2 with 2-segmented rami, legs 3-4 with 1-segmented rami ..... *Perissopus dentatus*
on *Sphyrna zygaena* [Hewitt, 1967]

8a Genital complex with convex lateral margins, abdomen visible in dorsal view (fig. 10,11); legs 1-3 with 2-segmented rami, leg 4 with 1-segmented rami ..... *Pandarus* spp. 9

9 First free trunk segment with lateral plates equal to, or slightly longer than, second free segment (fig. 10).. *Pandarus bicolor*
on *Galeorhinus australis, Isurus oxyrinchus, Notorynchus cepedianus, Squalus acanthias** [Hewitt, 1967]

9a First free trunk segment with lateral plates extending well beyond second free segment (fig. 11) ..... *Pandarus satyrus*
(appears as *P. cranchii* in Hewitt, 1967, but Cressey, 1968, suggests it should be regarded as *P. satyrus*);
on *Galeorhinus australis, Isurus oxyrinchus.*

10 Abdomen 1-segmented (fig. 12) 11

10a Abdomen 2-segmented (fig. 13) 12

11 Legs 1-4 with rami 2-segmented ..... *Demoleus latus*

11a Legs 1-3 with rami 2-segmented, leg 4 with rami 1-segmented ..... *Nogagus borealis*
(as *Nesippus borealis* in Hewitt, 1967);
on *Isurus oxyrinchus.*
(♂ of *Nesippus orientalis* unknown (?), may key out here)

12 (CARE! 3 options) Legs 1-2 with 2-segmented rami, legs 3-4 with 1-segmented rami ..... *Perissopus dentatus*

12a Legs 1-3 with rami 2-segmented, leg 4 with rami 1- or 2-segmented 13

12b Leg 1 with rami 2-segmented, legs 2-3 with exopod 3-segmented (fig. 14) 15

13 Third free trunk segment with antero-lateral spine-like projections (fig. 15) ..... *Phyllothyreus cornutus*

13a Third free trunk segment without spine-like projections (fig. 13) ..... *Pandarus* spp. 14

14 Fourth free trunk segment with 2 pairs of posteriorly-directed marginal spines (fig. 17) ..... *Pandarus satyrus*

14a Fourth free trunk segment with a pair of minute marginal spines, and small blunt lobes posteriorly (fig. 13) .. *Pandarus bicolor*
[Note: Hewitt, 1967 :248, records ♂ fourth leg rami as 1-segmented, but this conflicts with the generic diagnosis and may be in error]

15 Exopod of leg 4 3-segmented ..... *Echthrogaleus coleoptratus*

15a Exopod of leg 4 1-segmented ..... *Dinemoura* spp. 16

16 Third free trunk segment with posteriorly-directed lobes (fig. 18) ..... *Dinemoura latifolia*

16a Third free trunk segment without such lobes (fig. 19) ..... *Dinemoura producta*

KEY TO ADULT COPEPODA PARASITIC ON TELEOSTS
(CONTINUED FROM COUPLET 1a, PAGE 19).

1 Mesoparasitic; body of female large, conical, warty (fig. 31), enclosed in a sac embedded in flesh of host .. PHILICHTHYIDAE p 35

1a Ectoparasitic; clinging and mobile, or attached but at least partly exposed 2

2 Body with some sharp and distinct intersegmental divisions dorsally (fig. 32-34) 3

2a Body without sharp and distinct intersegmental divisions (fig. 37-41, 44-56, 59, 60) 7

3 (CARE! 3 options) Body dorso-ventrally flattened; anterior part covered by dorsal shield (fig. 35) 4

3a Body not dorso-ventrally flattened; dorsal shield present, bearing postero-dorsal stylets .... EUDACTYLINIDAE p31 (part - also occur on elasmobranchs)

3b Body not dorso-ventrally flattened; dorsal shield absent (fig. 32) 6

4 Dorsal or dorso-lateral plates absent (apart from dorsal shield) ... CALIGIDAE p28

4a Dorsal or dorso-lateral plates present on 1 or more segments (figs 56, 57) 5

5 Dorsal plate of third free segment rounded posteriorly and with a small median notch; abdomen broad, flattened and concealed in dorsal view by genital complex (fig. 56); egg strings long, coiled between abdomen and dorsal plate ..... CECROPIDAE p30

5a Dorsal plate of third free segment with a deep posterior notch, flanked by posteriorly directed lobes (females only) (fig. 57); abdomen visible in dorsal view; egg strings long, straight, trailing well beyond end of abdomen ..... EURYPHORIDAE p31

6 Five pairs of legs well developed, sixth pair vestigial (fig. 32-33) ..... BOMOLOCHIDAE p28

6a Three pairs of legs well developed (fig. 58) ..... ERGASILIDAE p31

7 Anterior part deeply buried in tissues of host, expanded to form a holdfast of variously shaped lobes (figs 54, 55, 59) 8

7a Anterior part not deeply buried in host, and not expanded into anchor-like lobes (CARE: Host epithelium may proliferate over part of the body of the parasite) 9

8	Holdfast comprising usually 3, often finger-like radiating processes; trunk bulky, with pronounced sigmoid flexure; 4 pairs of minute legs close behind holdfast; egg strings trailing, tightly coiled helices, uniseriate (fig. 59)	PENNELLIDAE	p34
8a	Holdfast comprising pairs of blunt lobes (fig. 54-55); trunk flattened; legs absent; egg strings long, trailing, multiseriate	SPHYRIIDAE	p35
9	Second maxillae enlarged (often greatly) into arm-like processes, forming an attachment organ (fig. 46, 47, 60)	10	
9a	Second maxillae not enlarged as above	11	
10	Second maxillae cylindrical, fused at tip forming a bulla (fig. 46) ..... (part - also occur on Elasmobranchs) (males small and attached to females)	LERNAEOPODIDAE	p 33
10a	Second maxillae flattened, strap-like (fig. 60) encircling a gill filament; tips not fused but each firmly inserted into its own basal portion by a claw-and-socket joint	NAOBRANCHIIDAE	p 34
11	Some pairs of legs large, foliaceous (female) (fig. 49), or long, cylindrical (male) (fig. 61)	LERNANTHROPIDAE	p 33
11a	Legs small, not foliaceous	12	
12	Trunk with blunt processes (often large) and sinuous lateral margins; legs unsegmented; egg strings multiseriate (fig. 37-40); (males small, attached to female)	CHONDRACANTHIDAE	p 30
12a	Trunk without prominent processes, lateral margins not sinuous; 2 pairs of biramous legs; egg strings uniseriate (fig. 44, 45)	HATSCHEKIIDAE	p 31

FAMILY: BOMOLOCHIDAE

Body distinctly segmented, not flattened, cephalothorax broadened. Sexes similar in appearance, but males smaller and with differently shaped abdomen. Egg sacs elongate-oval, about as long as abdomen, multiseriate. Occur in branchial chamber or on outer surface of teleosts, occasionally in nasal sinuses.

Key to New Zealand species:

1 With 5 free thoracic segments; third segment approximately rectangular and of same width as second (fig. 32) ..... *Pseudoeucanthus australiensis* on *Chrysophrys auratus* [Roubal, Armitage & Rohde, 1983] [Male unknown].

1a With 4 free thoracic segments in male; 3 free thoracic segments in female (segments 3 + 4 fused); third (third + fourth) segment oval and distinctly narrower than second (fig. 33, 34) ..... *Unicolax chrysophryenus* on *Chrysophrys auratus* [Roubal et al., 1983].

FAMILY: CALIGIDAE

Body flattened dorso-ventrally, cephalothorax expanded and including first 3 leg-bearing thoracic segments, 4th leg-bearing segment free, next 2 segments fused (= genital complex); egg strings long, trailing, uniseriate. Males (where known) resemble females, but often slightly smaller and with differences in appendages and genital complex. Occur usually on outer body surface where their streamlined profile helps to resist dislodgement.

Key to genera in New Zealand:

1 Lunules (anterior suckers) present at base of first antennae (fig. 35) ..... *Caligus* spp.

1a Lunules absent (fig. 36) ..... *Lepeophtheirus* spp.

Caligus

No key to species has been devised; the following lists the species known from hosts occurring in the region:

C. aesopus; on *Seriola grandis* [Hewitt, 1963]

C. brevis; on *Odax pullus, Pseudolabrus celidotus, Ps. miles, Ps. fucicola** [Hewitt, 1963]

C. buechlerae; on *Tripterygion capito* [Hewitt, 1964e]

C. coryphaenae; on *Katsuwonus pelamis* [Jones unpubl.; Kabata, 1979]

C. pelamydis; on *Thyrsites atun* [Hewitt, 1963]

C. productus; on *Katsuwonus pelamis* [Hewitt, 1963. Note: record need confirmation for New Zealand; see also Cressey & Cressey, 1980]

C. sclerotinosus; on *Chrysophrys auratus* [Roubal et al., 1983]

C. willungae; on *Chrysophrys auratus* [Roubal et al., 1983]

C. spp.; on *Arripis trutta**, *Thunnus maccoyii* [Jones, unpubl.]

Lepeophtheirus

No key to species has been devised; the following lists the species known from hosts occurring in the region:

L. argentus; on *Hyperoglyphe antarctica* [Hewitt, 1963]

L. distinctus; (on *Genypterus blacodes*) [Hewitt, 1963]

L. erecsoni; on *Latridopsis ciliaris, Odax pullus, Pseudolabrus celidotus, Ps. cinctus, Ps. miles, Ps. fucicola** [Hewitt, 1963] [Note: records of *L. scutiger* in Hewitt, 1963, have been shown to be this species by Boxshall & Bellwood, 1981]

L. hastatus; on *Mola mola* [Hewitt, 1971]

L. heegaardi; on *Lepidopus caudatus* [Hewitt, 1963]

L. nordmanni (=*L. insignis* of Hewitt, 1964c); on *Mola mola* [Hewitt, 1971]

L. polyprioni; on *Polyprion moene, P. oxygeneios* [Hewitt, 1963]

L. sekii; on *Chrysophrys auratus* [Roubal et al., 1983]

L. sp.; on *Latridopsis ciliaris**.

FAMILY: CECROPIDAE

A small family of 5 genera; well-developed cephalothoracic shield undivided except for a few shallow grooves; male similar to female. One species in New Zealand ..... *Cecrops latreillii* (fig. 56); on *Mola mola** [Hewitt, 1968a].

FAMILY: CHONDRACANTHIDAE

Females bulky in form, almost without signs of external segmentation, appendages reduced, but with (often numerous) blunt lobes projecting from lateral and/or dorsal surfaces. Egg sacs elongate-oval. Males (fig. 63) are minute parasites attached to the female. Occur in mouth, branchial chamber and other protected sites.

Key to females (adapted from Yamaguti, 1963; Kabata, 1979):

1 Head without processes; trunk with small posterior processes only (fig. 38) .. *Acanthochondria incisa* on *Helicolenus papillosus**, *Scorpaena cardinalis* [Ho, 1975]

1a Head with processes (fig. 37) 2

2 Trunk with only minute ventro-lateral processes (fig. 41) ..... *Pseudochondracanthus chilomycteri* on *Allomycterus whitleyi* [Ho, 1975]

2a Trunk with pronounced lateral and posterior processes at least (fig. 37) 3

3 Trunk with a row of dorsal processes (fig. 39) ..... *Chondracanthus lotellae* on *Cheilodactylus macropterus**, *Pseudophysis bachus** [Ho, 1975] [Male, fig. 63]

3a Trunk without a row of dorsal processes 4

4 Trunk with 8-9 pairs of lateral processes (some long), and 2 pairs on cephalothorax (fig. 37) ..... *Chondracanthus distortus* on *Cyttus novaezelandiae*, *Zeus australis* [Ho, 1975]

4a Trunk with 2-3 pairs of short blunt lateral processes, and 1 pair of postero-lateral processes (fig. 40).. *Chondracanthus genypteri* on *Genypterus blacodes** [Ho, 1975]

[Note: undetermined species of *Chondracanthus* (?) have been taken at Kaikoura from *Macruronus novaezelandiae** and *Thyrsites atun**. Jones (unpubl.) reports an undetermined species from *Physiculus breviusculus*.]

FAMILY: ERGASILIDAE

A large family of relatively unmodified forms, retaining body segmentation and many appendages; females mature, become fertilised and even produce eggs away from the host, their parasitic existence being apparently brief; males planktonic, not parasitic (?).

(In New Zealand, the sole known species is primarily an estuarine fish parasite but some of the hosts are also found in coastal waters). *Abergasilus amplexus* (fig. 58); on *Arripis trutta, Pseudophycis bachus, Retropinna retropinna, Rhombosolea leporina, Rh. plebeia, Rh. retiaria.* [see Hewitt, 1978 for description of ♀; Jones, 1981 for revision and for ♂].

FAMILY: EUDACTYLINIDAE

(see also p.20) This family is mostly confined to Elasmobranchs; a common gill parasite of the groper appears, however, to belong here. It superficially resembles *Eudactylina*, but has *Kroyeria*-like stylets on the cephalothorax.
Unidentified species on *Polyprion oxygeneios**

FAMILY: EURYPHORIDAE

Similar to Caligidae, but wing-like processes present on thorax; sexes similar. One species in New Zealand .. *Euryphorus brachypterus* (fig. 57); on *Allothunnus fallai, Thunnus maccoyii.* [Note: appears as *Elytrophora brachyptera* in Hewitt, 1968b; Cressey & Cressey, 1980].

FAMILY: HATSCHEKIIDAE

Body elongated, definite segmentation lost in 'neck' region between cephalothorax and genital complex though 'segment-like' constrictions may occur there. Egg strings shorter than body, trailing, uniseriate. Males (where known) similar to females but with smaller genital complex.

1 Legs 1-3 biramous (fig. 42) ..... *Congericola kabatai*
on *Conger verreauxi* [Hewitt, 1975; and see Hewitt, 1969c, description as *Congericola pallidus*].

1a Legs 1-2 biramous, legs 3-4 reduced to papillae or absent ..... *Hatschekia* spp.
[Specimens of this genus are morphologically somewhat variable; the following key is provided by Dr J.B. Jones - see Jones, 1985] 2

2 Postero-lateral margins of trunk bearing distinct cornute processes (fig. 43, 44), or small hemispherical knobs not part of oviducal openings 3

2a Postero-lateral margins of trunk forming distinct lobes on either side of abdomen, or taper to abdomen without lobes or processes 4

3 Cephalothorax with prominent bulges or protuberances on lateral or postero-lateral margins; frontal margin complexly crenate ..... *Hatschekia crenata*
on *Lepidopus caudatus** [Hewitt, 1969b].

3a Cephalothorax with evenly rounded lateral margins ..... *Hatschekia conifera*
(= *H. acuta*, see Kabata, 1981a); on *Brama brama*.

4 Lateral margins of cephalothorax with prominent bulges, prominences or indentations, not evenly rounded or oval ..... *Hatschekia pagrosomi*
on *Chrysophrys auratus* [Roubal et al., 1983].

4a Lateral margins of cephalothorax evenly rounded or oval (fig. 45) ..... *Hatschekia quadrata*
on *Allomycterus whitleyi* [Hewitt, 1969b].

FAMILY: LERNAEOPODIDAE

[one of the few families associated with Teleosts as well as Elasmobranchs - see p.21]

Key to New Zealand species (females only) occurring on Teleosts:

1 Posterior trunk processes absent 2

1a Posterior trunk processes present, (ventral to egg sacs) (fig. 46) ..... *Neobrachiella insidosa lageniformis* on *Merluccius australis*; [*Neobrachiella* sp. indet.; on *Pseudophycis bachus*, Jones, unpubl.].

2 Bulla mushroom-shaped (fig. 47) ..... *Clavellopsis sargi* on *Chrysophrys auratus* [Roubal et al., 1983].

2a Bulla flat, button-like ..... *Clavellodes* sp. indet. on *Cheilodactylus macropterus* [Vooren & Tracey, 1976].

FAMILY: LERNANTHROPIDAE

Females bulky, with broad plate-like processes on trunk; some legs also lamellar. Males usually much smaller, the processes often elongated and finger-like; they are less common (in some species unknown) and characters for separating the species are not available; they may be tentatively identified by association with identified females.

Key to New Zealand species (females only), adapted from Hewitt, 1968c:

1 Egg strings trailing behind body (fig. 48) ..... *Lernanthropus microlamini* on *Seriolella brama** [Hewitt, 1968c] [Jones, unpubl., reports a *Lernanthropus* sp. from *Centrolophus niger*].

1a Egg strings coiled and concealed by dorsal plate of fourth trunk segment (fig. 49, 50) 2

2 Foliaceous legs (=pereiopod 3) broad, bluntly rounded tip reaching *ca* end of body (fig. 49) ..... *Aethon* spp. 3

2a Foliaceous legs (= pereiopod 4) bifid with pointed tips reaching well beyond end of body (fig. 50; male, fig. 61) ..... *Paralernanthropus foliaceus* on *Cheilodactylus macropterus, Rexea solandri, Thyrsites atun**.

3 (CARE! 3 options) Cephalothorax as in fig. 51 ..... *Aethon garricki* on *Cheilodactylus macropterus**.

3a Cephalothorax as in fig. 52 ..... *Aethon percis* on *Parapercis colias*.

3b Cephalothorax as in fig. 53 ..... *Aethon morelandi* on *Latridopsis ciliaris**.

FAMILY: NAOBRANCHIIDAE

Formerly included in Lernaeopodidae, but the enlarged second maxillae do not form a bulla characteristic of that family; instead they form an encircling ring, the tip of each being inserted back on the body. (Yamaguti, 1963, who established the family, refers to these appendages as first maxillipeds). Egg sacs compact, multiseriate. Males, minute, attached to female.

One species in New Zealand ....."*Naobranchia*" sp.; on *Helicolenus papillosus**. [Note: observations made at Kaikoura suggest that the two maxillae, although arising symmetrically, follow the same direction around a gill filament; attachment is enhanced by adhesive discs on the inner surfaces of the maxillae. Pilgrim, unpubl.].

FAMILY: PENNELLIDAE

Grossly modified forms, including very large females (up to 600 mm); with deeply penetrating, expanded root-like holdfast; egg strings uniseriate; males minute, attached to female. One species in New Zealand ..... *Trifur lotellae* (fig. 59); on *Macruronus novaezelandiae**, *Parapercis colias**, *Pseudophycis bachus**, *Ps. breviusculus* [Thomson, 1890]. [Note: older specimens frequently bear filamentous growths, hydroids, etc., on the trunk and lower neck].

FAMILY: PHILICHTHYIDAE

A small family (*ca* 30 spp.), in which females are deeply embedded in flesh etc. of the host, which responds by forming a cyst. (Kabata, 1979, refers to this situation as endoparasitism, but communication with the outside sea water is retained through a pore). Females large; males minute, vermiform, with caudal furca, often several within each cyst.

One species (undescribed) from New Zealand ..... *Sarcotaces* sp.; on *Pseudophycis bachus** [see Yamaguti, 1963; Izawa, 1974, for an account of the genus].

FAMILY: SPHYRIIDAE

Females grossly modified; with body comprising a cephalothorax expanded into a 'holdfast' embedded in host tissue, an elongated 'neck', and a bulbous trunk with numerous posterior processes. Egg strings very long, trailing, multiseriate. Males minute, attached to female - resemble those of Lernaeopodidae. Life histories not known for New Zealand species. Occur on outer surface of host, where their very large size (up to 200 mm long) renders them conspicuous.

1 Each posterior trunk process consisting of repeatedly subdividing branches (fig. 54) ..... *Sphyrion laevigatum*
on *Genypterus blacodes**, *Cheilodactylus macropterus*. [Thomson, 1890].
[Immature ♀♀ and associated ♂♂ from *Coelorhynchus australis** may be this species].

1a Each posterior trunk process consisting of many long straight branches arising from a central stalk (fig. 55) ..... *Lophoura (= Rebelula) laticervix*
on *Coelorhynchus fasciatus*. [Hewitt, 1964b].

HOST SYNONYMS

Names of host fishes are taken from the lists prepared by Francis (1979) and Roberts & van Berkel (1982); as some of these differ from those in Hewitt & Hine (1972), Ayling & Cox (1982), or in papers containing parasite descriptions, the following synonymies are given:

This paper:	Elsewhere:
Elasmobranchs	
Mustelus lenticulatus	*Mustelus antarcticus*
Notorynchus cepedianus	*Notorhynchus pectorosus*
Teleosts	
Allomycterus whitleyi	*Allomycterus jaculiferus*
Cheilodactylus macropterus	*Nemadactylus macropterus*
	Dactylopagrus macropterus
Coelorhynchus australis	*Coelorinchus australis*
Coelorhynchus fasciatus	*Coelorinchus fasciatus*
Helicolenus papillosus	*Helicolenus percoides*
Hyperoglyphe antarcticus	*Hyperoglyphe porosa*
Odax pullus	*Odax vittatus*
	Coridodax pullus
Pseudolabrus fucicola	*Pseudolabrus pittensis*
Pseudophycis bachus	*Physiculus bacchus* [specific name variously spelled]
Pseudophycis breviusculus	*Physiculus breviusculus*
Scorpaena cardinalis	*Ruboralga cardinalis*
Seriola grandis	*Seriola lalandi*
Thunnus maccoyii	*Thunnus maccoyi*
Zeus australis	*Zeus faber*
	Zeus japonicus

HOST-PARASITE LIST

-- known records from the Kaikoura-Banks Peninsula region --

Elasmobranchs

Carcharodon carcharias	*Anthosoma crassum*
	Dinemoura producta
	Nemesis lamna lamna
Cetorhinus maximus	*Nemesis lamna vermi*
Galeorhinus australis	*Lernaeopoda galei*
	Kroyeria (?*lineata*)
Isurus oxyrinchus	*Anthosoma crassum*
	Nemesis lamna lamna
Lamna nasus	*Anthosoma crassum*
	Echthrogaleus coleoptratus
Mustelus lenticulatus	*Lernaeopoda galei*
	Nesippus orientalis
Prionace glauca	*Echthrogaleus coleoptratus*
Raja nasuta	*Charopinus parkeri*
	Nesippus orientalis
Squalus acanthias	*Charopinus parkeri*
	Eudactylina sp.
	Lernaeopoda galei
	Pandarus bicolor

Teleosts

Arripis trutta	*Caligus* sp.
Cheilodactylus macropterus	*Aethon garricki*
	Chondracanthus lotellae
Coelorhynchus australis	? *Sphyrion laevigatum*
Genypterus blacodes	*Chondracanthus genypteri*
	Sphyrion laevigatum
Helicolenus papillosus	*Acanthochondria incisa*
	"Naobranchia" sp.
Latridopsis ciliaris	*Aethon morelandi*
	Lepeophtheirus sp.
Lepidopus caudatus	*Hatschekia crenata*
Macruronus novaezelandiae	*Chondracanthus* sp.
	Trifur lotellae
Mola mola	*Cecrops latreillii*
Parapercis colias	*Trifur lotellae*
Polyprion oxygeneios	EUDACTYLINIDAE, indet.
Pseudolabrus fucicola	*Caligus brevis*
	Lepeophtheirus erecsoni
Pseudophycis bachus	*Chondracanthus lotellae*
	Sarcotaces sp.
	Trifur lotellae
Seriolella brama	*Lernanthropus microlamini*
Thyrsites atun	*Chondracanthus* sp.
	Paralernanthropus foliaceus

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The figures are reproduced, with some modifications, from publications as follows: fig. 17 from Cressey (1967), fig. 57 from Cressey & Cressey (1980); figs 1-14, 18, 19, 22-27, 35, 36, 42, 43, 45, 48-53, 55, 56, 58, 61, from various papers by Hewitt; figs 37-41, 63, from Ho (1975); fig. 29 from Kabata (1964); figs 15, 16, 20, 21, 28, 44, 62, from Kabata (1979); fig. 46 from Kabata & Ho (1981); fig. 31 from Moser (1977); figs 32-34, 47, from Roubal et al. (1983); fig. 54 from Thomson (1890); fig. 60 from Yamaguti (1963). Fig. 59 is original.

An early draft of some of this paper was prepared by the late Hugo Stufkens, to whose memory the present version is dedicated.

GENERAL REFERENCES

Excellent accounts of the morphology and biology are to be found in Kabata (1970, 1979), and in some standard parasitology texts such as Cheng (1973) and Schmidt & Roberts (1981).

Kabata (1979) presents a masterly account of the group, including classification and aspects of phylogeny; although much of the taxonomy is primarily circumscribed around the British fauna, it is profusely and thoroughly illustrated with original drawings, and serves a most useful function here.

Yamaguti (1963) provides a 'world-wide' coverage of the Copepoda (and Branchiura), almost exclusively taxonomic and in places at variance with Kabata's more recent treatment; many of the figures are taken from original papers but they remain a useful source of information. Both Yamaguti and Kabata contain good keys, workable at this distance.

Scott & Scott (1913) and, to a lesser extent, Wilson (1932) have been somewhat superseded in the taxonomic sense, but both contain many useful illustrations, and include some features of life histories.

LITERATURE CITED

AYLING, T. and COX, G.J. 1982. *Collins guide to the sea fishes of New Zealand.* Collins, Auckland. 343 pp.

BOXSHALL, G.A. and BELLWOOD, D.R. 1981. A redescription of *Lepeophtheirus erecsoni* Thomson, 1891 and some comparisons with *L. scutiger* Shiino, 1952 and a new species, *L. sheni* (Crustacea: Copepoda). *Journal of the Royal Society of New Zealand 11:* 75-85.

CHENG, T.C. 1973. *General parasitology.* Academic Press, New York. xxv + 965 pp.

CRESSEY, R. 1967. Revision of the family Pandaridae (Copepoda: Caligoida). *Proceedings of the United States National Museum 121(3570)*: 1-133.

CRESSEY, R.F. 1968. Caligoid copepods parasitic on *Isurus oxyrinchus* with an example of habitat shift. *Proceedings of the United States National Museum 125(3653)*: 1-26.

CRESSEY, R. and CRESSEY, H.B. 1980. Parasitic copepods of mackerel- and tuna-like fishes (Scombridae) of the World. *Smithsonian Contributions to Zoology, No. 311*: iv + 186 pp.

FRANCIS, M.P. 1979. Checklist of the marine fishes of Kaikoura, New Zealand. *Mauri Ora 7*: 63-71.

[Note: To facilitate comparison with previous literature, and to avoid confusion, Hewitt's papers have been alphabeticised following their listing in Hewitt & Hine, 1972].

HEWITT, G.C. 1963. Some New Zealand parasitic Copepoda of the family Caligidae. *Transactions of the Royal Society of New Zealand, Zoology 4*: 61-115.

HEWITT, G.C. 1964a. The postchalimus development of *Lepeophtheirus polyprioni* Hewitt, 1963 (Copepoda: Caligidae). *Transactions of the Royal Society of New Zealand, Zoology 4*: 157-159.

HEWITT, G.C. 1964b. A new species of *Lophoura* (Shyriidae[sic], Copepoda) from New Zealand waters. *Transactions of the Royal Society of New Zealand, Zoology 5*: 55-58.

HEWITT, G.C. 1964c. The occurrence of *Lepeophtheirus insignis* Wilson (Copepoda parasitica) in New Zealand waters and its relationship to *L. molae* Heegaard. *Transactions of the Royal Society of New Zealand, Zoology 4*: 153-155.

HEWITT, G.C. 1964e. A new species of *Caligus* (Copepoda) on a species of *Tripterygion* from New Zealand. *Transactions of the Royal Society of New Zealand, Zoology 5*: 123-130.

HEWITT, G.C. 1967. Some New Zealand parasitic Copepoda of the family Pandaridae. *New Zealand Journal of Marine and Freshwater Research 1*: 180-264.

HEWITT, G.C. 1968a. *Cecrops latreillii* Leach (Cecropidae, Copepoda) on *Mola mola* in New Zealand waters. *Records of the Dominion Museum 6*: 49-59.

HEWITT, G.C. 1968b. *Elytrophora brachyptera* Gerstaecker (Euryphoridae, Caligoida) from New Zealand waters, with a tentative revision of the genus. *Transactions of the Royal Society of New Zealand, Zoology 10*: 117-126.

HEWITT, G.C. 1968c. Some New Zealand parasitic Copepoda of the family Anthosomidae. *Zoology Publications from Victoria University of Wellington No. 47*: 1-31.

HEWITT, G.C. 1969b. Two new species of *Hatschekia* (Copepoda, Dichelesthiidae) from New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 3*: 159-168.

HEWITT, G.C. 1969c. Some New Zealand parasitic Copepoda of the family Eudactylinidae. *Zoology Publications from Victoria University of Wellington, No. 49*: 1-31.

HEWITT, G.C. 1971. Species of *Lepeophtheirus* (Copepoda, Caligidae) recorded from the ocean sunfish (*Mola mola*) and their implications for the Caligid genus *Dentigryps*. *Journal of the Fisheries Research Board of Canada 28*: 323-334.

HEWITT, G.C. 1975. New name for some *Congericola* (parasitic Copepoda) from New Zealand conger eels. *New Zealand Journal of Marine and Freshwater Research 9*: 563-565.

HEWITT, G.C. 1978. *Abergasilus amplexus* gen. et sp. nov. (Ergasilidae; parasitic Copepoda) from fishes in Lake Ellesmere, New Zealand. *New Zealand Journal of Marine and Freshwater Research 12*: 173-177.

HEWITT, G.C. and HINE, P.M. 1972. Checklist of parasites of New Zealand fishes and of their hosts. *New Zealand Journal of Marine and Freshwater Research 6*: 69-114.

HO, J.-S. 1975. Cyclopoid copepods of the family Chondracanthidae parasitic on New Zealand marine fishes. *Publications of the Seto Marine Biological Laboratory. Kyoto 22*: 303-319.

HURLEY, D.E. 1961. A checklist and key to the Crustacea Isopoda of New Zealand and the Subantarctic Islands. *Transactions of the Royal Society of New Zealand, Zoology 1*: 259-292.

IZAWA, K. 1974. *Sarcotaces*, a genus of parasitic copepods (Cyclopoida: Philichthyidae), found on Japanese fishes. *Publications of the Seto Marine Biological Laboratory. Kyoto 21*: 179-191.

JONES, J.B. 1981. *Abergasilus amplexus* Hewitt, 1978 (Ergasilidae: Copepoda) from New Zealand, with a description of the male. *New Zealand Journal of Marine and Freshwater Research 15*: 275-278.

JONES, J.B. 1985. A revision of *Hatschekia* Poche, 1902 (Copepoda: Hatschekiidae) parasitic on marine fishes. *New Zealand Journal of Zoology 12*: in press.

KABATA, Z. 1964. Revision of the genus *Charopinus* Krøyer, 1863 (Copepoda: Lernaeopodidae). *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i Kjøbenhavn 127*: 85-112.

KABATA, Z. 1970. Crustacea as enemies of fishes. In: Snieszko, S.F. and Axelrod, H.R. (Eds.). *Diseases of fishes*. T.F.H. Publications, Jersey City. 171 pp.

KABATA, Z. 1979. *Parasitic Copepoda of British fishes*. Ray Society, London. *No. 152*: 468 pp.

KABATA, Z. 1981a. Relegation of *Hatschekia acuta* Barnard, 1948, to synonymy with *Hatschekia conifera* Yamaguti, 1939 (Copepoda: Siphonostomatoida). *Canadian Journal of Zoology 59*: 2080-2084.

KABATA, Z. 1981b. Copepoda (Crustacea) parasitic on fishes: problems and perspectives. *Advances in Parasitology 19*: 1-71.

KATABA, Z. and HO, J.S. 1981. The origin and dispersal of hake (Genus *Merluccius*: Pisces: Teleostei) as indicated by its copepod parasites. *Oceanography and Marine Biology. An Annual Review 19*: 381-404.

MOSER, M. 1977. *Sarcotaces* sp. (Copepoda) on the head of *Physiculus rastrelliger* from El Salvador. *Canadian Journal of Zoology 55:* 258-260.

ROBERTS, C.D. and VAN BERKEL, J. 1982. Additional records of marine fishes from Kaikoura. *Mauri Ora 10*: 133-137.

ROUBAL, F.R., ARMITAGE, J. and ROHDE, K. 1983. Taxonomy of metazoan ectoparasites of snapper, *Chrysophrys auratus* (family Sparidae), from southern Australia, eastern Australia and New Zealand. *Australian Journal of Zoology, Supplementary Series No. 94*: 1-68.

SCHMIDT, G.D. and ROBERTS, L.S. 1981. *Foundations of parasitology* (2 ed.). The C.V. Mosby Company, St. Louis. xi + 795 pp.

SCOTT, T. and SCOTT, A. 1913. *The British parasitic Copepoda.* Ray Society, London. *No. 95*: xi + 257 pp.; *96*: xii + 72 plates.

THOMSON, G. 1890. Parasitic Copepoda of New Zealand, with descriptions of new species. *Transactions and Proceedings of the New Zealand Institute 22*: 353-376.

VOOREN, C.M. and TRACEY, D. 1976. Parasites in tarakihi (Pisces: Cheilodactylidae) from three areas around New Zealand. *New Zealand Journal of Marine and Freshwater Research 10*: 499-509.

WILSON, C.B. 1932. The copepods of the Woods Hole region Massachusetts. *Bulletin of the United States National Museum 158*: xix + 635 pp.

YAMAGUTI, S. 1963. *Parasitic Copepoda and Branchiura of Fishes.* Interscience Publishers, New York. ix + 1104 pp.

Fig. 1 *Anthosoma crassum* ♀ [Dichelesthiidae]: lateral

Fig. 2 *Dinemoura producta* ♀ [Pandaridae]: dorsal

Fig. 3 *Echthrogaleus coleoptratus* ♀ [Pandaridae]: dorsal

Fig. 4 *Demoleus latus* ♀ [Pandaridae]: third pereiopod

Fig. 5 *Pandarus bicolor* ♀ [Pandaridae]: second pereiopod

Fig. 6 *Nesippus orientalis* ♀ [Pandaridae]: dorsal

Fig. 7 *Dinemoura latifolia* ♀ [Pandaridae]: dorsal

Fig. 8 *Perissopus dentatus* ♀ [Pandaridae]: dorsal

Fig. 9 *Phyllothyreus cornutus* ♀ [Pandaridae]: dorsal

Captions: gen.c. -- genital complex
p.l. -- posterior lobe
tr -- trunk segment

Scale lines: a = 5 mm
b = 1 mm
c = 0.5 mm

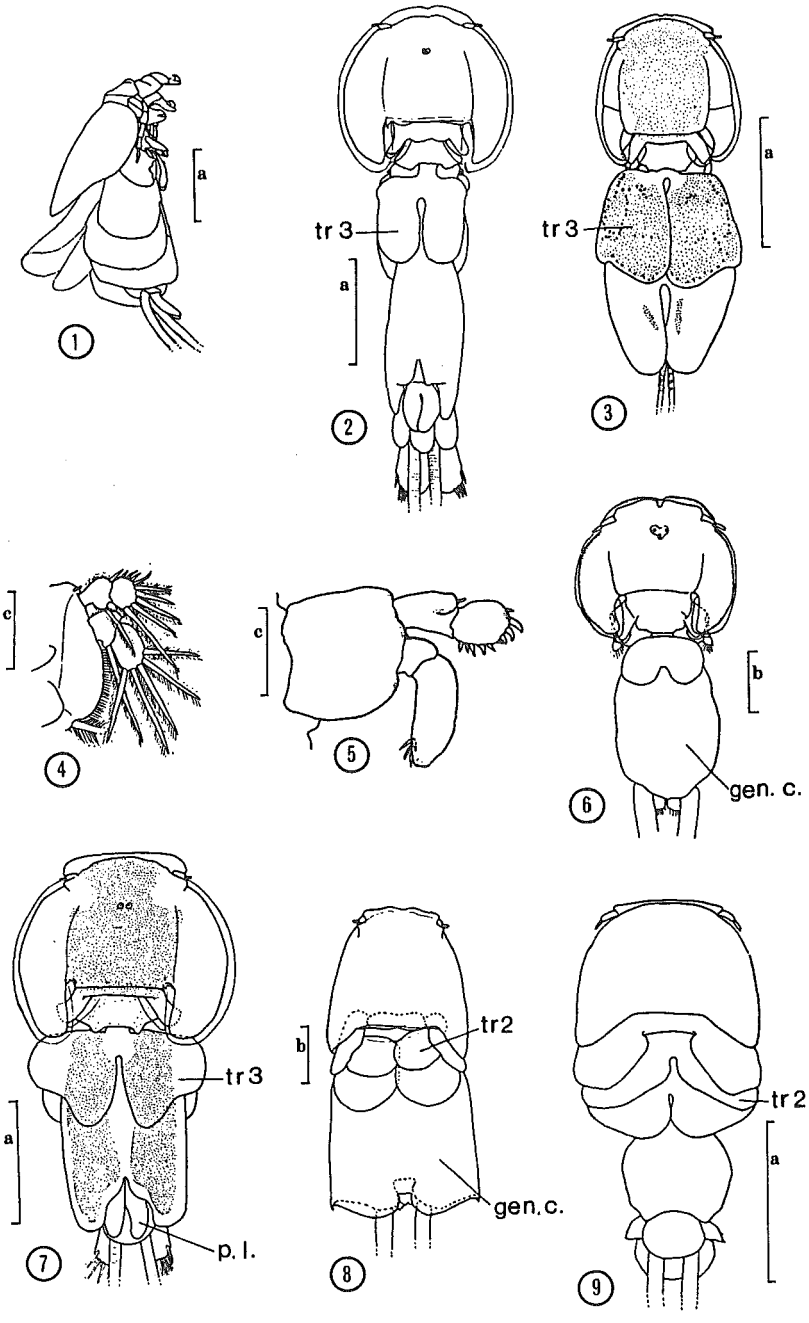

a
1
tr 3
a
2
tr 3
a
3
c
4
c
5
b
gen. c.
6
tr3
a
p. l.
7
b
tr2
gen.c.
8
tr2
a
9

Fig. 10 *Pandarus bicolor* ♀ [Pandaridae]: dorsal

Fig. 11 *Pandarus satyrus* ♀ [Pandaridae]: dorsal

Fig. 12 *Demoleus latus* ♂ [Pandaridae]: end of body, dorsal

Fig. 13 *Pandarus bicolor* ♂ [Pandaridae]: dorsal

Fig. 14 *Dinemoura producta* ♂ [Pandaridae]: second pereiopod

Fig. 15 *Phyllothyreus cornutus* ♂ [Pandaridae]: dorsal

Fig. 16 *Eudactylina* sp. [Eudactylinidae]: first antenna, ventral

Fig. 17 *Pandarus satyrus* ♂ [Pandaridae]: end of body, dorsal

Fig. 18 *Dinemoura latifolia* ♂ [Pandaridae]: end of body, dorsal

Fig. 19 *Dinemoura producta* ♂ [Pandaridae]: end of body, dorsal

Captions: abd. -- abdomen
an -- antennal segment
gen.c. -- genital complex
tr -- trunk segment

Scale lines: a = 5 mm
b = 2 mm
c = 1 mm
d = 20 µm

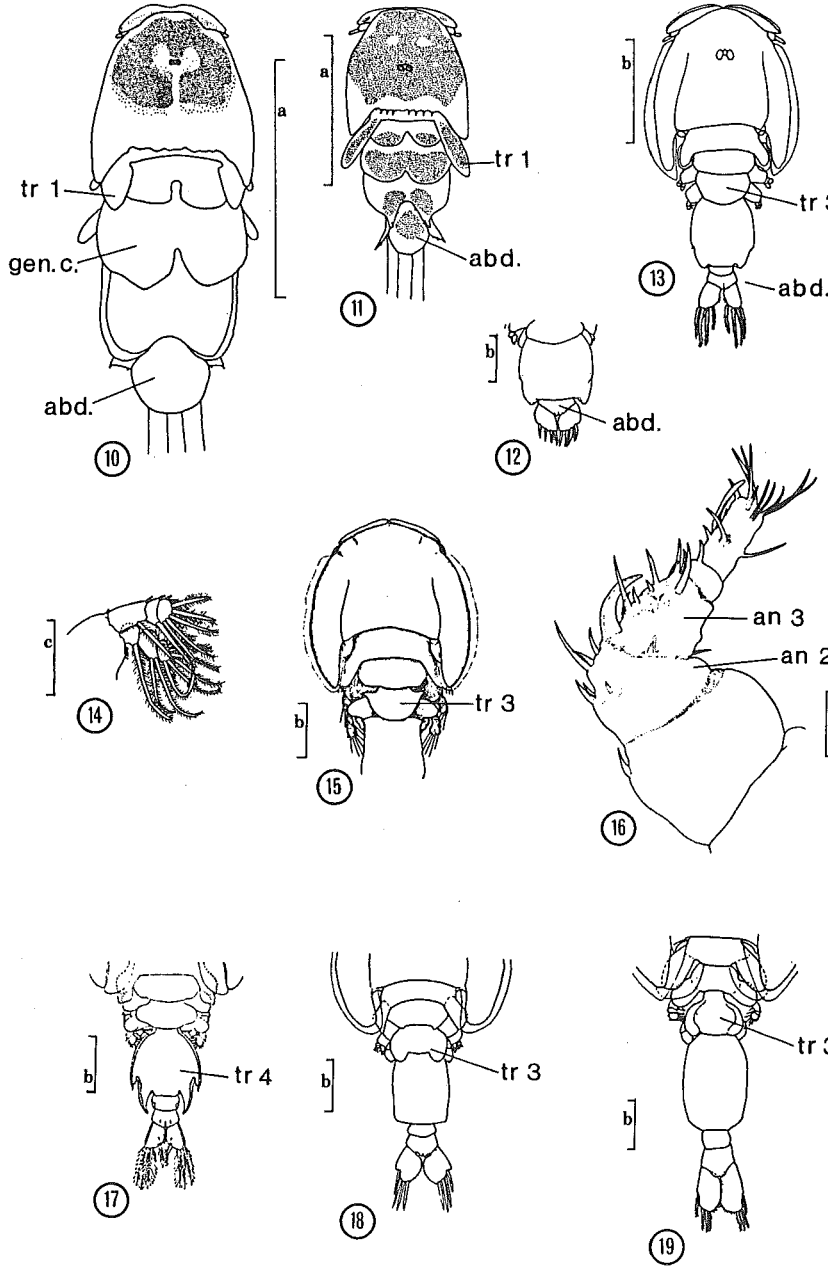

tr 1
gen. c.
abd.
a
10
a
tr 1
abd.
11
b
tr 3
abd.
13
b
abd.
12
c
14
tr 3
b
15
an 3
an 2
d
16
b
tr 4
17
b
tr 3
18
tr 3
b
19

Fig. 20 *Eudactylina* sp. ♀ [Eudactylinidae]: maxilliped

Fig. 21 *Eudactylina* sp. ♂ [Eudactylinidae]: maxilliped

Fig. 22 *Nemesis lamna vermi* ♀ [Eudactylinidae]: dorsal

Fig. 23 *Nemesis lamna lamna* ♀ [Eudactylinidae]: dorsal

Fig. 24 *Nemesis robusta* ♀ [Eudactylinidae]: dorsal

Fig. 25 *Nemesis robusta* ♂ [Eudactylinidae]: dorsal

Fig. 26 *Nemesis lamna lamna* ♂ [Eudactylinidae]: dorsal

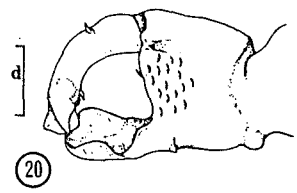
Fig. 27 *Nemesis lamna vermi* ♂ [Eudactylinidae]: dorsal

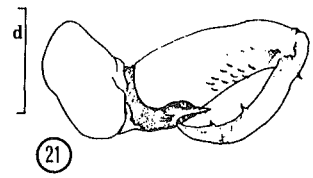
Fig. 28 *Lernaeopoda galei* ♀ + ♂ [Lernaeopodidae]: lateral

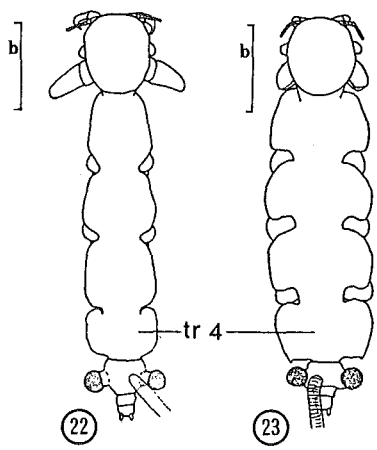
Fig. 29 *Charopinus parkeri* ♀ [Lernaeopodidae]: dorso-lateral

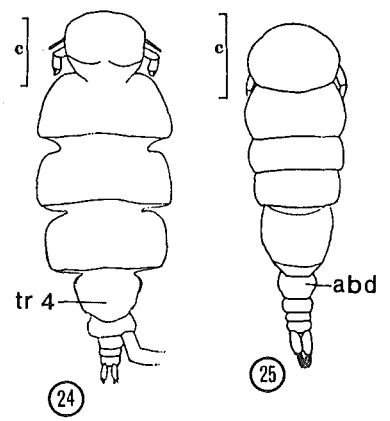
Captions: abd. -- abdominal segment
ceph. -- cephalothorax
mx 2 -- second maxilla
tr -- trunk (segment)

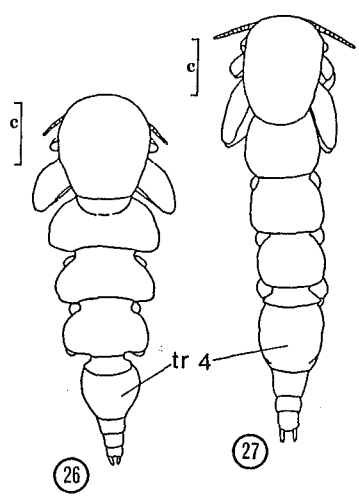
Scale lines: a = 10 mm
b = 2 mm
c = 1 mm
d = 100 µm

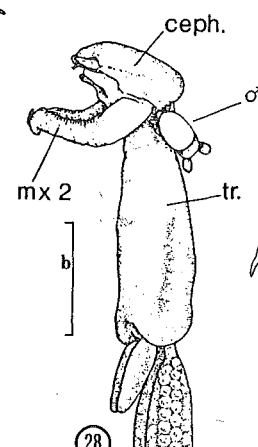

d
20


d
21


b
tr 4
22
b
23


c
tr 4
24
c
abd 1
25


c
c
tr 4
26
27


ceph.
♂
mx 2
tr.
b
28

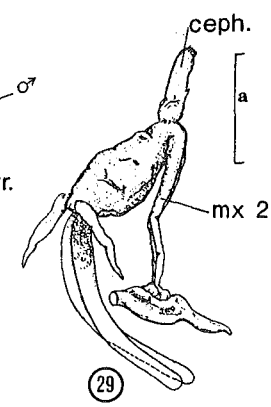

ceph.
a
mx 2
29

Fig. 31 *Sarcotaces* sp. ♀ [Philichthyidae]: ventro-lateral

Fig. 32 *Pseudoeucanthus australiensis* ♀ [Bomolochidae]: dorsal

Fig. 33 *Unicolax chrysophryenus* ♂ [Bomolochidae]: trunk, dorsal

Fig. 34 *Unicolax chrysophryenus* ♀ [Bomolochidae]: trunk, dorsal

Fig. 35 *Caligus aesopus* ♀ [Caligidae]: carapace and anterior trunk, dorsal

Fig. 36 *Lepeophtheirus argentus* ♀ [Caligidae]: carapace and anterior trunk, dorsal

Fig. 37 *Chondracanthus distortus* ♀ [Chondracanthidae]: dorsal

Fig. 38 *Acanthochondria incisa* ♀ [Chondracanthidae]: dorsal

Fig. 39 *Chondracanthus lotellae* ♀ [Chondracanthidae]: dorsal

Fig. 40 *Chondracanthus genypteri* ♀ [Chondracanthidae]: dorsal

Captions: lu. -- lunule

th -- thoracic segment

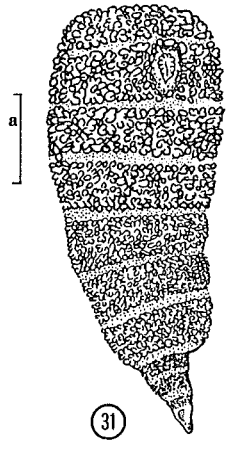
Scale lines: a = 10 mm

b = 2 mm

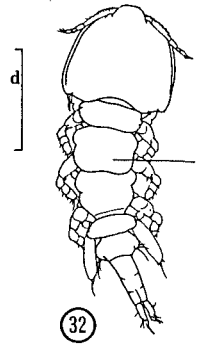
c = 1 mm

d = 0.5 mm

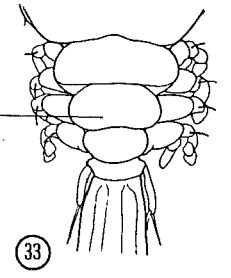
e = 0.2 mm



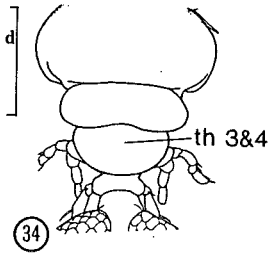
31



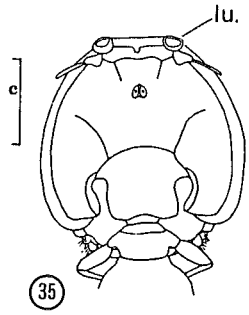
32



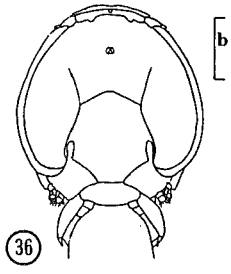
33



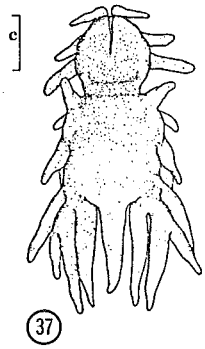
34



35

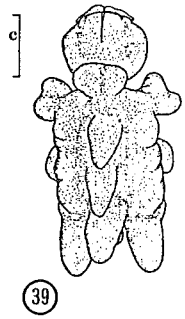


36

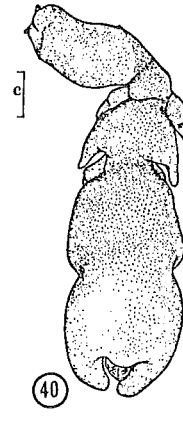


37

38



39



40

Fig. 41 *Pseudochondracanthus chilomycteri* ♀ [Chondracanthidae]: lateral

Fig. 42 *Congericola kabatai* ♀ [Hatschekiidae]: first pereiopod

Fig. 43 *Hatschekia crenata* ♀ [Hatschekiidae]: end of body, dorsal

Fig. 44 *Hatschekia conifera* ♀ [Hatschekiidae]: dorsal

Fig. 45 *Hatschekia quadrata* ♀ [Hatschekiidae]: dorsal

Fig. 46 *Neobrachiella insidiosa lageniformis* ♀ [Lernaeopodidae]: lateral

Fig. 47 *Clavellopsis sargi* ♀ [Lernaeopodidae]: ventral
inset: detail of bulla

Fig. 48 *Lernanthropus microlamini* ♀ [Lernanthropidae]: dorsal

Fig. 49 *Aethon percis* ♀ [Lernanthropidae]: lateral

Fig. 50 *Paralernanthropus foliaceus* ♀ [Lernanthropidae]: lateral

Fig. 51 *Aethon garricki* ♀ [Lernanthropidae]: anterior end, dorsal

Fig. 52 *Aethon percis* ♀ [Lernanthropidae]: anterior end, dorsal

Fig. 53 *Aethon morelandi* ♀ [Lernanthropidae]: anterior end, dorsal

Captions: mx 2 -- second maxilla

Scale lines: a = 5 mm
b = 2 mm
c = 1 mm
d = 0.5 mm
e = 0.2 mm
f = 50 µm

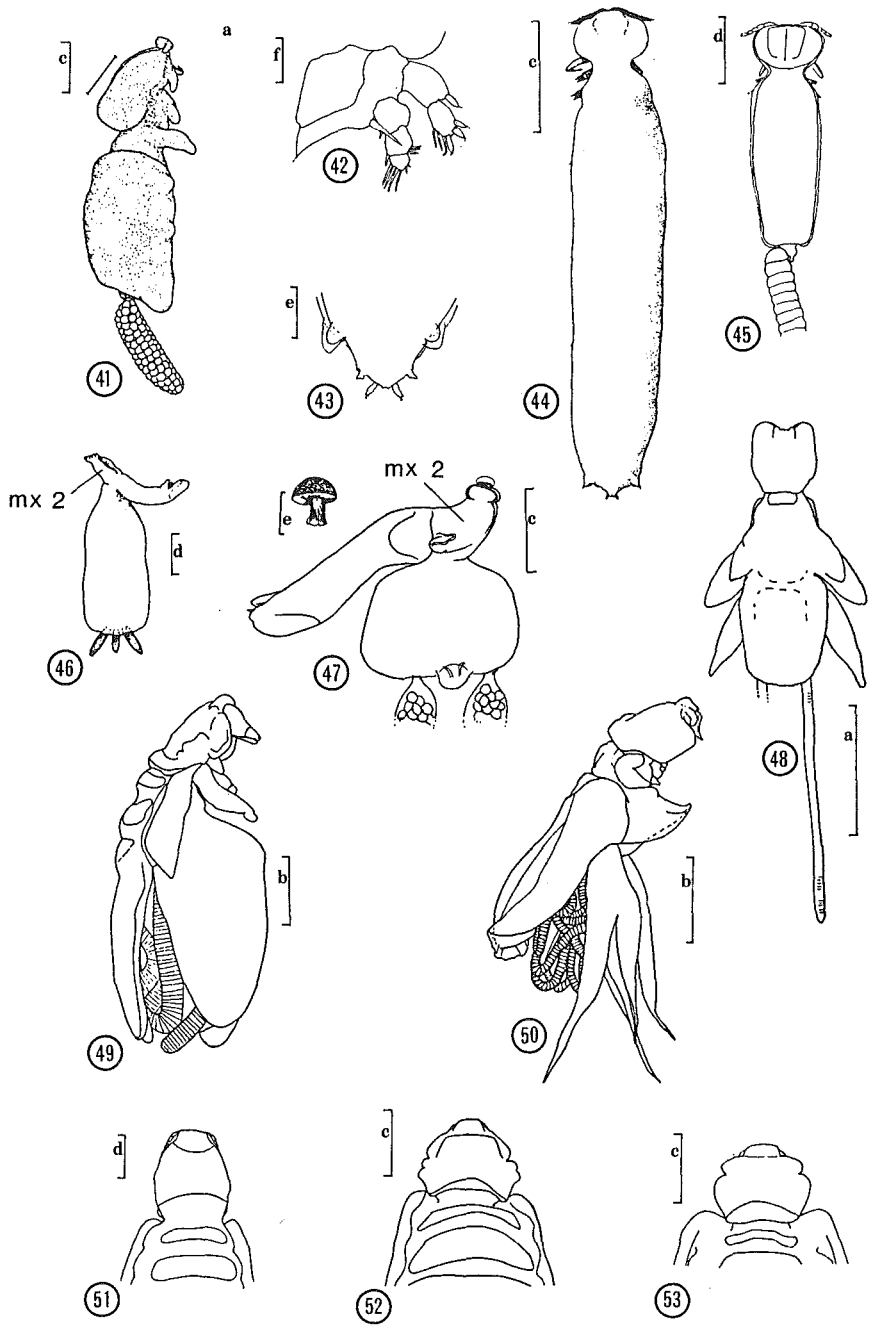

a
c
41
f
42
e
43
c
44
d
45
mx 2
d
46
mx 2
e
c
47
a
48
b
49
b
50
d
51
c
52
c
53

Fig. 54 *Sphyrion laevigatum* ♀ [Sphyriidae]

Fig. 55 *Lophoura laticervix* ♀ [Sphyriidae]

Fig. 56 *Cecrops latreillii* ♀ [Cecropidae]: dorsal

Fig. 57 *Euryphorus brachypterus* ♀ [Euryphoridae]: dorsal

Fig. 58 *Abergasilus amplexus* ♀ [Ergasilidae]: dorsal

Fig. 59 *Trifur lotellae* ♀ [Pennellidae]: ventral (with hydroids)

Fig. 60 *Naobranchia* sp. ♀ [Naobranchiidae]: lateral

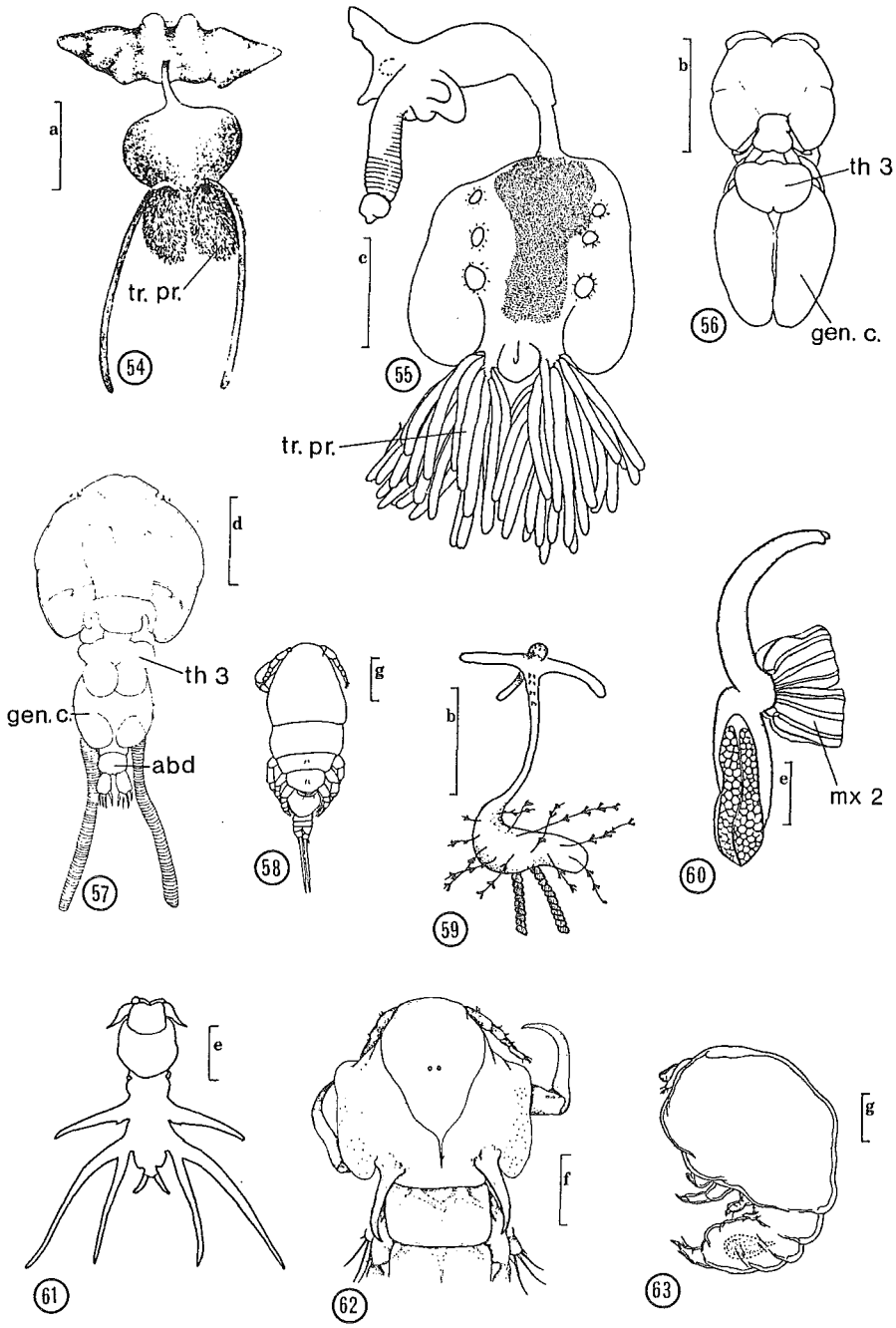
Fig. 61 *Paralernanthropus foliaceus* ♂ [Lernanthropidae]: dorsal

Fig. 62 *Kroyeria* sp. ♀ [Kroyeriidae]: front of body, dorsal

Fig. 63 *Chondracanthus lotellae* ♂ [Chondracanthidae]: lateral

Captions:
- abd -- abdomen
- gen.c. -- genital complex
- mx 2 -- second maxilla
- th -- thoracic segment
- tr. pr. -- trunk processes

Scale lines:
- a = 20 mm
- b = 10 mm
- c = 5 mm
- d = 2 mm
- e = 1 mm
- f = 0.2 mm
- g = 0.1 mm


a
tr. pr.
54
b
55
c
tr. pr.
b
th 3
56
gen. c.
d
th 3
gen. c.
abd
57
g
58
b
59
e
mx 2
60
e
61
f
62
g
63